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ON BUDDING IN ANIMALS.

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THROUGHOUT the Vegetable Kingdom budding and branching are two of the most familiar terms, as well as most salient features. Thus, for instance, the horticulturist introduces into a slit in another plant a bud with a fragment of bark from a rose, and he separates the bulbil from the axil of the leaf in the bulbiferous lily, and inserts it in the ground. The arboriculturist, again, by the spray of the branches against the wintry sky, can distinguish the species of tree, and he utilizes the ready growth of branches in the formation of a quickset hedge. In the higher forms of animal life—such as the Vertebrates—on the other hand, Harvey's morphological generalization of "*Omne vivum ex ovo*" holds without exception, and we have to make a considerable descent in the zoological scale before meeting with an approach to the condition in plants, *viz.* budding and branching. In certain of the more lowly organized types, however, both conditions are often conspicuously present.

And here let me explain that by budding is meant that condition in which an offshoot or new animal arises from a parent-stock or nurse-stock as a rudiment, and gradually develops into the form of the parent, a portion—it may be a very small portion—of whose structure is originally utilized in its formation.

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Some observers and many writers draw hard and fast distinctions between budding and fission (binary, cross, longitudinal, and diagonal). The former (budding) is said to occur—for instance, in the simplest animals—when the portion separated is smaller than the parent, the latter (fission) when it is about the same size. Again, in an animal with a linear series of segments, the term budding is applied to those instances in which from one or two segments a complete animal with head and internal organs is formed; while fission is said to take place in those cases in which a considerable number of the adult segments are cut off to form the new animal, the diameter of which is thus more nearly that of the parent-stock. But it is clear that if in the latter case a new head, brain, and sense-organs are developed out of an ordinary segment, it also is more or less an example of budding.

In dealing with certain divisions of the subject, however, more precise terms are employed. Thus, for instance, in the Marine Annelids, the terms “schizogamy” and “scissiparity” are generally used.

In *schizogamy* (Syllids, &c.) a part of the individual only acquires ova or other elements, and separates. The head of the bud has large eyes, but no mouth, and only serves to disseminate the ova or other elements, and then disappears. No new products are formed. *Scissiparity* (fission) differs from *schizogamy* in so far as it is a veritable multiplication, the two (parent and bud) resembling each other, and developing either ova or other elements independently.

In the lowest group of animals, the Protozoa, simple division of the body is very common, but in many (e. g. *Arcella* and *Pelomyxa*), after conjugation, numerous buds, which are smaller than the parent, are given off at once. Moreover, in such as *Codosiga*, a colony is formed by budding, and, as in this and other instances the buds do not separate, the branching structure resembles a miniature zoophyte.

In these simply organized animals budding would appear to be the most natural method of increase, the buds either remaining separate and gradually attaining the bulk of the original, or, as in *Codosiga*, developing into a continuously branched organism. As true eggs are unknown in the group, there can



be no question as to whether increase can be most advantageously carried out by the one method or the other, and this has to be borne in mind in considering Weismann's remark,* that in the lower animals, "whenever increase apart from the ordinary method became advantageous, it was more readily and better supplied by fission and budding." Moreover, as in these minute animals there is no distinction of the sexes, nature is deprived of one of the means she is stated to employ to produce variation (Brooks and Weismann). Further, no clear differentiation into elements destined to build up the body (somatic) and those associated with the continuance of the species (though the nucleus has long been connected with the latter) exists, and thus the process of budding is simplified. Lastly, it is difficult to trace any relationship, in such forms, between the budding and special adaptation due to demands made by the conditions of life.

In the great division of the Metazoa budding in one form or another especially characterizes the lower types. Thus buds are common amongst the Sponges, and various species can be multiplied by cutting off pieces and planting them on suitable sites. The bath-sponge of the Levant (Turkey-sponge), for instance, has been successfully propagated in this manner. Complex branching is likewise prevalent in the group, and the two features just mentioned probably weighed with the illustrious Ehrenberg in tenaciously asserting that Sponges were vegetables. The so-called gemmules, again, found in such species as the fresh-water Sponge (*Spongilla*) are modifications of buds. As eggs of the ordinary kind occur in these animals, and are in many forms the chief method of spreading them in the waters around, a choice between the two modes of increase is now possible, each being adapted, as in the fresh-water Sponge, for its special season. The formation of gemmules, that is, little masses of sponge-tissue, in addition to the ordinary method of increase, probably was slowly acquired, first by the separation of the little masses of sponge-tissue, then the formation of a capsule, and, lastly, by the modification of the remarkable spicules characteristic of the latter. Sponges which formed buds of this kind might be supposed to have a better chance of

* II., p. 216.

survival than those which did not, but they would less quickly spread the species over a wide area.

The remarkable persistence of types like *Cliona*, which not only form branches freely, but bore in calcareous rocks and shells, is a striking feature in the group. The moniliform and branched tunnels in dead shells are conspicuous on the celebrated shell-beach at Herm; besides boring in living shells, it is thus one of the main agents in disintegrating shells on the sea-bottom. Their beautifully dendritic patterns—with the enlargements where the oscula occur—are well seen in the very thin lower valves of southern *Anomia*, which are too thin for the boring of any known annelid, and especially of the cosmopolitan *Polydora*. A distinguished author formerly held that sponges did not bore, but only took possession of the tunnels of such annelids as *Polydora* in shells and rocks. A very thin (almost like paper) lower valve of *Anomia* was sent to him in spirit without remark. When held to the light the moniliform and finely branched tunnels of *Cliona* were clearly seen with the oscula at the enlargements. Nothing could have been more convincing, and, so far as known, no further remarks on the subject were made.

In no group is budding more conspicuous than in the hydroid stocks of the Cœlenterates, as shown in the simplest condition in such as *Hydra*, and in a more complex manner in the plant-like tufts of the hydroid zoophytes, which are either dimorphic or polymorphic. As the food-canal of the entire colony is continuous, it is evident that by this process of branching the balance is more or less maintained, since new mouths and additional predatory tentacles spring into existence with the other parts of the organism. Moreover, great variation occurs in the nature of the buds, which Arnold Lang calls the sisters of the nutritive polypites; for, whereas in some the buds containing the eggs and sperms remain attached, in many they swim freely as the delicate glassy circles—the familiar jelly-fishes or hydro-Medusæ—so that buds from the most distant parent-stocks commingle. And, as if even these steps were not sufficiently complex, we find that in certain species (*Codonium*, *Lizzia*) these transparent swimming jellies give off others by budding from the stalk (*manubrium*), or from the edge of the

umbrella or disk (*Hybocodon* and *Sarsia prolifera*). Buds are also seen in *Hydra tuba*, the primary condition in the development of the scyphomedusæ such as *Aurelia*. The whole group of the Corals, again, is characterized by free budding and branching, so that the outlines of many are beautifully arborescent, for, as a rule, the new growths remain attached to the old. In *Fungia*, however, the young Coral is budded from a fixed axis or stock, and subsequently leads an independent existence.

Why, it may be asked, is budding so prominent in the Cœlenterates? Is it due to the fact that the so-called "somatic cells" of Weismann still retain a certain capacity for renewing the species, so that a small number of them are able to give rise to a new organism in the form of a bud? But some of these cells likewise develop the ordinary differentiated elements for increase, so that their functions would seem to be twofold. Moreover, in forming the Medusa-bud, it is possible that besides the "somatic cells" from the axis (blastostyle) the reproductive cells may be introduced into the developing bud, and give rise at a subsequent stage to the eggs or other elements characteristic of each.

The plant-like form of the chief examples of the group, moreover, is most favourable for continuous budding, so that by such means, for instance in the hydroid zoophytes, the capsules containing the eggs or other elements are greatly increased in number on any individual stock. Such certainly would be an advantage to the species. In the same way in other forms the swimming jellies or medusoids which are budded off to develop the eggs or other elements give the species enormous powers of distribution—powers which the mere discharge of eggs or larvæ on the site of the parent-stock could scarcely accomplish. But though these little jelly-fishes carry the eggs to distant regions, and mingle with others reared in diverse localities, it has to be shown that those which have this means of dispersion are greatly more abundant than those which do not possess them. Certainly such rapidly growing forms as *Obelia*, with their swimming buds, would appear to be more plentiful in some localities than Sertularians, which develop directly, and which would seem to be the more primitive type, since the distribution of the eggs by means of the Medusa-bud is a more complex

arrangement. Again, the duration of the life of the stocks from which the buds issue is an important point, because it is possible that some may be annual, as in the case of *Gonothyraea Loveni* on the Mussels of the Eden, and as likewise occurs in the fresh-water Polyzoa. The budding of the somatic cells of the organism therefore would not alone suffice to preserve the species, and hence the necessity for a method resulting in the development of a pelagic medusa in which the eggs are produced, and, moreover, carried throughout the ocean to new sites by its intrinsic swimming powers and the effects of currents.

In connection with the budding and branching of zoophytes, some very interesting observations have recently been made by Jaques Loeb.* It is known that the growth of zoophytes takes place according to certain definite laws, the inferior end sending off root-like processes, while the upper continues the axis, and gives off branches with the cups for the polypites. Loeb found that if the zoophyte (*Antennularia*) is suspended in sea-water upside down the lower end (now the upper) gives off branches with the polypites on the upper side, while the former upper end gives off roots. If placed horizontally, the branches on the lower side grow vertically downwards in the form of root-like processes, which fix themselves to the surface of the glass (geotropic). The branches on the upper side either perish or produce long slender perfectly straight stems, which grow vertically upwards. At parts of the upper surface of the main axis, however, new stems grow vertically upward, and give off typical little branches with polyps. If placed obliquely with the normal upper end highest a new stem arises from the apex, and roots from the lower end, while if inverted the same thing happens. Gravitation thus appears to determine the place of origin of organs. In fragments of *Margelis* (*Bougainvillea*) all the stems which touch the glass give rise to roots, the free parts giving origin to polypites. Contact with a solid body thus plays the same rôle as gravitation does in *Antennularia*. In *Pennaria* he produced roots at both ends of a small stem that bore no polyps. If a solid body be brought into contact with it, it begins to grow away from it, and the new stem is soon nearly perpendicular to the surface. The foregoing manifestations are called by Loeb "Heteromorphism."

* Biol. Lect., Woods Hall, 1894, p. 37 *et seq.*

Again, he found that if a piece of *Tubularia* was suspended in the water horizontally by the middle, it produced a head at each end. It is interesting in this connection to remark that *Cerianthus*, one of the anemones frequenting sand, gives off tentacles from the aboral margin of a wound of the body-wall.

It is worthy of note that in the phylum of Echinoderms budding is generally absent from the adult as a normal mode of increase, though it is well known that renewal of lost parts is very general, a disk regenerating arms and a detached arm reproducing a disk and other arms. Yet in *Linckia* (*Ophidiaster*) *multiflora* buds arise from the tips of the rays. The regularity of their stellate bodies and their brittle nature do not seem to favour this method of development, though there may be other and more occult causes. In the young condition of several members of the group, however, the rudiment of the adult is budded off from a remarkable larva (*Echinopædium*), or from a reptant form (as in *Cribrella*). These larvæ therefore contain within them the germ-plasm from which the adult is formed, and which at a certain stage develops, while the larvæ themselves disappear. The adult is thus in one sense a bud of the larva, and the one is indispensable to the other, for no bud could be formed if the larvæ were swept off at an early stage. Such types therefore appear to encounter a double series of dangers—first as larvæ which never attain the adult state, and, secondly, as minute buds from the former, which have to pass through early and precarious stages before reaching the adult form. It has to be borne in mind, however, that in many the larval stages are pelagic while the adults live on the bottom, so that the conditions of life are very different. Nevertheless, some might suppose that it would have been sufficient for such forms to have sprung directly from eggs—pelagic or otherwise—without the foregoing complex larval stages—for example, that resembling a painter's easel, with its remarkable spicular skeleton. Such may have arisen from the necessities of its surroundings, which thus, it may be supposed, caused the production of the larva which by and by took the form of a painter's easel, and then developed a bud which assumed the adult outline, and settled on the bottom. In the same way it is not easy to see what advantage the common Cross-fish could have gained

by the addition of its remarkable type (*Bipinnaria*) to its development. A pelagic larva developing directly—for aught that we know—would apparently have been equally efficacious in peopling the waters with its countless swarms. Yet it cannot be denied that these peculiar larvæ are characteristic of forms which occur in enormous numbers in the sea, as, for instance, the Sand-stars, Brittle-stars, and the common Cross-fishes.

Amongst the Worms, budding is remarkably prevalent in various groups. Even in the parasitic forms such as the Cestodes it is exemplified in the scolices of *Tænia cænurus* forming *Cænurus crebralis* in the Sheep, the daughter-scolices, each with its armed head, budding from the interior of the parent-cyst. Another example is the well-known *Tænia echinococcus* forming hydatids in man by the development in the liver and lungs of numerous daughter-vesicles, even to two generations. The advantages of budding in perpetuating the species are sufficiently illustrated in the former case. Thus, if no bud were formed on the interior of the cyst, the death of the Sheep would be that of the *Cænurus* also, but the presence of numerous buds suffices to spread them broadcast amongst the Dogs that eat the head of the Sheep. Thus the vicious circle is kept up, for the scolices become tape-worms in the Dogs, and their eggs are by and by introduced with food into the body of the living Sheep.

The soft ciliated worms called Turbellarians show great capacity for regenerating mutilated parts, while in some of the elongated forms the fragments become perfect animals, as in the Nemertean termed *Lineus sanguineus*, Jens Rathke, each fragment of which develops a head with brain, sense-organs, and other parts in a comparatively short time. Besides this power of regeneration, certain forms present a similar condition to the Echinoderms, in so far as the larval Nemertean is budded from the *Pilidium*. As many of the Nemerteans are littoral and confined to the bottom, such a method of increase would tend to carry them to distant sites, since during the growth of the *Pilidium* and thereafter during the development of the Nemertean bud a considerable space may have been traversed. Yet such forms would be exposed to the attacks of predatory crustaceans and other animals even more than the young of types like *Lineus obscurus*, which attain some size before leaving their protective capsules.

It is in the lower Turbellarians, however, that linear budding is conspicuous—for example, in *Microstoma* and *Stenostoma*—in which a chain is formed behind the adult. So little is known of the life-history of these forms that it is difficult to determine the advantages of linear budding in contrast with the young produced from eggs in the ordinary manner.

Linear budding likewise occurs in the Oligochætous division of the bristled Annelids, as in *Stylaria* and *Chaetogaster*. In *Stylaria lacustris*, O. F. Müller originally described two kinds of budding, viz. (1) That in which the last segment sprouted into a number of body-rings which ultimately constitute a new individual. This last segment gives origin to other buds, the hindmost being the oldest, and the anterior the youngest, as well as the smallest. After these buds have been thrown off the segment next in front takes on a similar function, and is able to reproduce buds. (2) When the body has attained the length of forty segments, suddenly a division begins in the middle, so that two bodies each of twenty segments are formed. Budding in the same species was next alluded to by Gruithuisen* in his account of its anatomy. Oscar Schmidt,† again, thought that the development of the bud in *Stylaria* took place after the manner of an embryo and its nurse. Max Schultze,‡ further, described a softening of two body-rings which develop an opaque cellular substance filling the segment symmetrically, and a new body-segment forms, and so on until a number of body- and tail-rings, as well as a head-segment anteriorly, are developed out of the end-segment. Then a new bud is formed in front, and again another, so that a series of three individuals, each with head, eyes, proboscis, and body-segments, is present. These are now detached, and the process is repeated. When, however, by these means the body of the parent-stock has been reduced to twelve or fourteen rings, a pause ensues. After forty or fifty segments have been developed by increase at the posterior end a new cycle commences, for the animal divides into two, as O. F. Müller described. The latter author thought that the separation took place between two segments, but Max Schultze

* 'Nova Acta Acad. Cæs. Leop.' Bd. xi. 1, pp. 243-248, 1823.

† 'Handbuch der vergl. Anat.' p. 293.

‡ 'Archiv f. Naturges.' 1849, pp. 293-304.

was of opinion that it occurred in the middle of a segment. He never found traces of eggs or other elements. Such, however, have been described by D'Udekem,* Claparède, and others in this species, and in *Æolosoma* and *Chætogaster*. The former author, indeed, found these elements mature, yet the example continued to reproduce by buds.† Moreover, in one bud these elements (male) were present. Vejdovsky,‡ in describing the linear budding of *Æolosoma*, points out that the bud arises irrespective of the presence of a special segment or zone. A slight thickening, the earliest indication of the ganglia, appears in a segment, a pair of short side-nerves following by and by, the alimentary canal and the ventral vessel being continuous with those of the parent. Then a pair of lateral branches arise from the vessel, two ciliated pits form, a pharynx is developed, and the bud is more or less complete.

In the same group of Worms (Oligochæta), *Lumbriculus*, though it does not present buds, has a remarkable facility for breaking in pieces in summer and autumn, each piece becoming an independent animal; while the eggs and other elements appear to be developed only in winter. A tendency to forking in Earthworms has also been described by Dr. Williamson and others.

On the whole, it is doubtful what advantage buds afford these Oligochæts. If no increase by eggs took place the case would be more simple, but such are found in the parent-stock, as well as in certain buds (*Stylaria* and *Æolosoma*). In some it would appear to be an accessory mode of increase, since it occurs at a different season from the ordinary method by eggs,§ and perhaps such conditions may be connected with the abundance or scarcity of food, or with the drying up of the waters which they frequent. As in the Polychæts, all the forms which show buds are small.

* 'Bullet. l'Acad. Roy. de Belgique,' 30 an. 2me sér. xii. p. 243, 1861.

† In the Naides budding is common at all seasons, reproduction occurring only at intervals.

‡ *Op. cit.* p. 161, Taf. 1, figs. 16, 29, &c.

§ Ray Lankester found that the sexual individuals (hermaphrodite) of *Chætogaster* on pond-snails ceased to show buds. They were larger than the fissiparous forms, and had an increased number of bristles.

In the group of Polychæts budding attains even greater prominence than in the foregoing, yet out of the thirty-seven families comprising the order it occurs only in two, viz. the Syllidæ and the Serpulidæ, and, as mentioned, the species are small.*

Since the days of O. F. Müller the formation of linear buds has been known in *Autolytus prolifer* (his *Nereis prolifera*), the Danish author having noticed a chain of three individuals, the youngest the most anterior, and observed that those which separated from their parent were filled with eggs. In the family of the *Syllidæ*, to which this species belongs, the most remarkable examples of budding occur. These have been described by many authors, some of whom, as, for instance, De Quatrefages, have termed the process one of alternation of generations. In essential particulars this consists in these Annelids of the budding from a nurse-stock of male and female buds, each differing from the other in external form. A series of gradations, indeed, may be observed from the condition in *Haplosyllis*, in which the posterior end is thrown off after the eggs or other elements in it are matured, to that in *Autolytus prolifer* and *Myrianida*, in which one or more buds, either male or female, form a chain at the posterior end of the nurse-stock.

In *Myrianida* the bud takes its origin in the segment (called by Malaquin† the formative zone) in front of the tail (pygidium). It is considerably narrower than the adult, and that next the latter is the youngest, several segments without feet, however, being in front of it. While pigment-touches are present in the youngest, there is no head, and thus Malaquin considers that the anterior extremity is subsequently formed, or, as he terms it, is a new stolon. Proceeding backward, the number of segments in the buds increases, and the parts attain greater complexity. Little thickenings—after the head is formed—indicate the tentacles, the median cylindrical, the lateral somewhat flattened. In the male the latter is a compound structure, according to Malaquin, the result of the fusion of the lateral (anterior) tentacles and the palpus, the outer limb of the bifid organ corresponding to the former, the inner to the latter. In

* Eyes have been found in a segment of *Eulalia* by Verrill.

† 'Recherches sur les Syllidiens,' Lille, 1893.

the female the organs appear in the same position, but the anterior lateral tentacle remains as the median—all being flattened, a fact which M. Malaquin considers is corroborative of his interpretation of the homologies of the bifid organ in the male. In the advanced free male bud (*Polybostrichus*, Müller) a short pair of lateral posterior tentacles occur in front of the dorsal eyes. Cylindrical tentacular cirri (dorsal and ventral) are present in the post-cephalic segment, whereas in the female only a single foliaceous one exists. The dorsal and ventral eyes appear as mere pigment-touches, and gradually attain greater complexity. The structure of the feet in the buds of different sexes in the main corresponds, the best developed organs being anterior, the most rudimentary posterior—that is, the most recently formed segments (from the formative zone) possess imperfectly developed feet. In the fully formed foot the flattened cirrus occurs dorsally, then follow the long swimming bristles, while the ventral division has bristles with short bifid tips differentiated from the shaft. In the males the first four segments are devoid of bristles, and in these the special elements are developed. In the females the natatory bristles commence on the first bristled segment, though occasionally they vary.

By and by the best developed buds, which show by their vigorous motions their independence, break off posteriorly, and swim freely in the water, the males—consisting of about thirty setigerous segments—being known to zoologists (before Alex. Agassiz cleared up the subject) under the name *Polybostrichus*, and the females—of about thirty-five segments in all—under the name *Sacconereis*. In the latter a pouch, occupying fifteen or sixteen segments of the median ventral region, is formed by a secretion from the epidermal glands, and in this the eggs are carried until they are developed into larvæ.

In *Autolytus Edwardsii*, De St. Joseph, several varieties of budding occur. Thus Malaquin found a cephalic thickening between the fortieth and forty-fifth segments, such thickening occurring therefore in an old segment and not in a new.* In front of the developing head is a zone of proliferation pertaining to the nurse-stock. After the formation of the head (which is

* In others between the twenty-fifth and twenty-eighth segments.

accomplished quickly) the eggs or other elements rapidly augment in bulk, the natatory bristles develop, the bud soon arrives at a certain degree of maturity, evinces energetic movements, breaks off, and swims freely. The nurse-stock then shows regeneration posteriorly.

In other cases, before the bud is detached, the proliferating zone in front of the tail (pygidium) of the nurse-stock gives rise to new segments, which considerably increase the length, so that on separation of the bud it is ready to proceed with a new bud posteriorly.

In a third form the head of the bud is found as before at the forty-first setigerous segment. Thereafter two indifferent segments (formative zone) in front of the head are formed, and a new bud is developed. The posterior bud, as in the previous cases, is formed out of certain of the older segments of the nurse-stock, and is thus more or less scissiparous in origin.

Again, a nurse-stock of forty or forty-two segments* is followed by a chain of buds (generally male, more rarely female), all formed at once by active proliferation. The terminal bud soon becomes free. Another of forty segments, with ovaries from the twenty-fifth to the fortieth (fifteen), then several young segments (four) with cirri and minute bristles, a formative zone, and a tail (pygidium). It becomes a female bud, with its head at the forty-first segment.

As a rule in examining such forms, Malaquin is of opinion that if the segments of the bud are of the same or larger diameter than those of the nurse-stock, then it is probably a case of fission; whereas in budding the segments have a smaller diameter than those of the parent or nurse-stock. In certain Syllidians, again—for example, *Autolytus longiferiens* and *Exogone gemmifera*—both direct development (epigamy) and budding (schizogamy) are present.

De Saint Joseph† thinks that, when the bud in *Autolytus* has considerable length, and consists of three regions, it is probably the result of fission. On the other hand, if short and of two regions, it is probably due to budding. While *Myrianida* has a

* In others the nurse-stock in front of the buds has only twenty-eight setigerous segments.

† 'Ann. des Sc. Nat.' 1886, p. 256.

chain of buds, *Virchowia* and *Procerastea* have only a single bud.

Pagenstecher* thought he observed lateral budding in *Exogone gemmifera*, but, as pointed out long before by CErsted,† this is simply a case of gestation. Vaillant,‡ again, considered he had discovered a series of buds in an Annelid apparently belonging to the *Terebellidæ*, but, as shown in 1868,§ this was due to a misapprehension; and Ehlers, of Göttingen, agreed. The only noteworthy case of lateral budding is that of *Syllis ramosa*|| of the 'Challenger,' though perhaps it is foreshadowed by the monstrosity subsequently mentioned by Langerhans¶ in *Syllis variegata*, and by the bifid tails described by Andrews in *Proceræa tardigrada***. More recently H. Parlin Johnson†† has given an account of the curious *Trypanosyllis gemmipara* from Puget Sound, in which a dense cluster of buds (about fifty) spring from "proliferating somite or somites" near the posterior extremity of the Syllid. They are attached by a short unsegmented pedicle. The remarkably branched *Syllis ramosa* was procured by the 'Challenger' on muddy ground in the Flores Sea, and also off Zebu—one of the Philippines—in a cup-shaped silicious sponge. It was situated above the wisp, and sent branches into the various canals of the sponge. No head occurred in any part from Zebu, but one head was found in that from the Flores Sea. No pharynx and no proventriculus was present. The free ends of the animal in many cases had a more or less finished appearance, as if sea-water carried in food to the moniliform alimentary canal. In others the ends presented developing buds. The body of the animal, indeed, has a furor for budding—laterally, terminally, and wherever a convenient point occurs. The young buds remain slender till they have reached considerable length, and into each a diverticulum of the alimentary canal of the parent enters. On attaining a certain size they give off other

* 'Zeitsch. f. w. Zool.' 1862, Bd. xii. p. 267.

† 'Archiv f. Naturges.' i. p. 20, 1845.

‡ 'Ann. des Sc. Nat.' 1865.

§ 'Trans. Roy. Soc. Edin.' xxv. p. 309.

|| 'Annelids of the Challenger,' p. 198, plate xxxi., &c., 1885.

¶ 'Nova Acta der K. Leop.-Car. Akad.' Bd. xlii. p. 102.

** 'American Naturalist,' 1892.

†† 'American Naturalist,' vol. xxxvi. p. 295, April, 1902.

buds, until the whole has a remarkably branched condition. The tail of the bud is early formed, and is soon furnished with two long cirri; indeed, it would seem to be more important than a head.

The currents through the sponge probably bring this curious Annelid its food, and carry out the free-swimming buds containing the eggs. It might be supposed by some that injuries from the sharp spicules of the sponge are connected with the tendency to form branches and buds, but recent experiments by Andrews in other forms show that incisions and similar lesions do not give rise to such growths. One example is thus fitted to take advantage of most of the facilities for accommodation offered by a single sponge, and many would say that the animal had been modified to suit its surroundings; yet other *Syllidæ* living in sponges are not thus affected.

A well-marked instance of linear budding (scissiparity) occurs in *Filigrana implexa*, one of the Serpulids, as described by Sars and Huxley. This little Annelid constructs masses of slender calcareous tubes resembling coral. The segments of the parent behind the sixteenth are budded off to form a separate animal, but the head and thorax are new formations. The eggs and other elements occur in the parent-stock, so that the buds contain neither eggs nor other elements as in *Myrianida* and *Autolytus*, though they afterwards acquire them.

The facility in budding which is possessed by the small Annelids just described is a remarkable feature, since in the Nereids the epitokous or epigamous condition alone occurs. The adults of the latter undergo a kind of metamorphosis, so that with the change in the form of the feet and the development of long swimming-bristles they are enabled to assume a pelagic life, and thus distribute widely the eggs and other elements. Yet it would not appear to be absolutely necessary for such forms to undergo this change in the feet, and acquire the provision of the swimming-bristles, since the well-known Palolo of the South Sea Islands—without any alteration in the shape of its feet—leaves its abode amongst rocks and corals and swims freely in the water. The rarity of the heads of this species amongst the pelagic forms indicates that the posterior region containing the eggs and other elements is thrown off to lead a brief existence amongst the inshore water.

The advantages of budding in these small Polychæts, such as *Autolytus*, appear to be the wide diffusion of the species, since the buds of both sexes and the females bearing the ovisacs are extremely active swimmers, and thus before the larvæ are ready for a free life they have been borne great distances. In our country it is in the colder months of the year, viz. from February to April, that they most abound in the ocean, a period less prolific in the larvæ of the Polychæts generally than the warmer months, though mature adults are not uncommon. What are the reasons which, with few exceptions, confine this mode of increase to the family of the *Syllidæ*? The question is difficult to answer. It is true the parent- or nurse-stocks are more or less sedentary, but they share this habit in common with many others which have only the ordinary method of increase, or which throw off only the posterior end with the eggs. The *Syllidæ*, however, are forms almost universally distributed, and in considerable abundance, from the Arctic to the Antarctic Ocean. The common species and its buds are often met with in the Arctic Seas, and the same remark applies to *Filigrana*. An interesting feature—specially dwelt on by Malaquin—is the gradual transition from forms with no further differentiation than the collection of the eggs and other elements in the posterior part of the body—which has swimming-bristles—to those in which this region presents several more or less mature and individualised buds. Nature thus truly does not advance by leaps. Moreover, while some of the family produce young directly from eggs, others increase only by buds. On the whole, it would seem that such Annelids have an organization so plastic as to render budding easy, and that in such forms as *Autolytus* and *Myrianida* it has been found highly advantageous in the struggle for existence. After all, there is nothing more wonderful in the soft tissues of a segment developing eyes, sense-organs, and other parts than their formation in the egg itself.

When we come to the Polyzoa, budding is everywhere a general feature, from the few in *Loxosoma*, which separate from the parent, to the arborescent polyzoaria of the marine and fresh-water Polyzoa, in both of which the new buds remain in connection with the old, and constitute complete colonies. In

Loxosoma, which is frequently an ecto-parasite of Annelids and Gephyreans, the buds of the larvæ arise as a surface-thickening (ectodermic), growing inwards to form the lophophore (Harmer), and in all probability a process of the stomach (hypoblast cells) goes to form the larval digestive system. *Loxosoma* at a given moment is unisexual, some having small, others large, eggs. In *Pedicellina* the buds spring from a creeping stolon. By means of ciliated young, which are produced from eggs, the range of the species is greatly extended. An analogous arrangement occurs in the creeping stem of *Rhabdopleura*, from which the polypides come off at various angles, and which has a remarkable tendency to form buds. The ova of this form are unknown, though Ray Lankester found the testes in the abdomen.

Still more striking is the condition in *Cephalodiscus* (a Diplochordate of Masterman), one of the most interesting discoveries of the 'Challenger,' for, in addition to its few though large eggs,* it has a furor for budding from the tip of the pedicle, the majority presenting from one to three or more buds at various stages. These buds are first observed as little processes projecting from the hypoderm, and in their earlier stages at least seem to have a channel of communication with the body-cavity of the adult. Moreover, the cavities characteristic of the latter are soon differentiated, viz. the cavity of the shield, the two collar-spaces, and the body-cavity divided by the mesenteries (dorsal and ventral). The small club-shaped bud soon develops a shield, which is proportionally large, with papillæ as rudiments of the plumes. The pedicle is short, and has a sucker-like hypodermic projection, and, since a peculiar curvature of the body takes place, the tip of the pedicle scarcely projects beyond the margin of the disc. Shortly after the symmetrical filaments on each side of the plumes are visible (though quite small), the bud separates from the adult, and as soon as—and sometimes even before—it is detached, a little bud appears near the tip of its pedicle. Thus the increase of the species by budding alone is very considerable, even comparatively young forms giving rise to a succession of buds.

The general form of the Polyzoa would lead us at first sight

* As in *Artisca*, in which they produce embryos about a third the size of the adult.

to expect increase by budding, since they approach in outline the hydroid zoophytes. *Loxosoma*, again, bears a superficial resemblance to the solitary forms such as *Hydra*, and, like the latter, it produces a few buds. The advantages of retaining a hold on a suitable site and extending the polyparium into an arborescent tuft, or a series of upright stalks, are in most cases obvious. The budding in such as *Cephalodiscus* takes place with rapidity, so that the new forms are soon ready to aid in the extension of the general home (polyparium), which is the joint secretion of the colony. The small number and large size of the eggs evidently point to a peculiar larval stage, and are probably also in relation with the feature just mentioned.

In the simple Ascidians, increase by budding takes place in the *Clavelinidæ* so as to form small colonies, in which each ascidiozoid, according to Herdman, has a distinct test, but all are connected by a common blood-system. The buds are formed on a stolon—as vascular outgrowths of the three layers from the posterior end of the body.

The compound Ascidians, again, increase by budding, so as to form colonies, in which the animals are buried in a common investing mass, and have no separate tests.

The *Salpæ* were formerly considered to be remarkable examples of budding, in which the aggregate forms were developed from the solitary in the region of the endostyle near the heart; but Brooks has shown that the germinal mass is present in the embryo of the solitary form, and extends into the stolon as the latter grows out. It consists of investing epithelium and ova, the latter forming a single row in the mature stolon, and in the course of constriction to form the chain of buds (*salpæ*) each gets, as a rule, a single egg, with its epithelial coat, which is differentiated into special organ (testis), follicle, and duct,* the latter attaching the egg to the dorsal wall of the chain-salpa. The solitary form thus does not arise from the chain-salpa, but from an egg passed into the chain-salpa from the preceding generation of the solitary form.

No budding occurs in the Articulates (*e. g.* Crustacea, Myriapoda, Arachnida, and Insecta), nor in the Mollusca or higher forms.

* Through which fertilization takes place.

In taking a general survey, therefore, of budding in animals, it is apparent that it reaches a high degree of frequency in certain lower groups characterized by a more plastic nature—for example, the Protozoa, the Sponges, the Cœlenterates, the Polyzoa, and compound Ascidians and the *Salpidæ*; while it occurs less frequently in the Cestode Worms, in the lower Turbellarians, in the bristled Annelids, and in the simple Ascidians. Moreover, it is apparent that its place is taken by parthenogenesis in such groups as the Crustaceans, Insects, and Rotifers. It comes therefore to be a question whether any common feature in regard to this mode of increase links together all the divergent groups just indicated, and whether any basis exists for making reliable deductions as to its origin.

So far as can at present be ascertained, comparatively few zoologists have touched on these questions. Weismann, it is true, tracing the division of labour and greater and greater complexity of organization, observes:—"Hence the single group would come to be divided into two groups of cells, which may be called somatic and reproductive. . . . Amongst the lowest Metazoa, such as polyps, the capacity for reproduction still exists to such a degree in the somatic cells that a small number of them are able to give rise to a new organism—in fact, new individuals are normally produced by means of so-called buds." The same author assumes that the entire absence of development by means of eggs "is to be primarily explained as an adaptation, and that the alternation between sexual and asexual multiplication met with in Hydromedusæ, Cestodes, and others has arisen from the demands made by the conditions of life—demands similar to those which have determined the alternations between monosexual and bisexual generation found in Insects, Crustaceans, and others. In both classes ordinary reproduction has been restricted to certain generations because it was not necessary in all of them, and because such restriction was a great advantage. The means by which this limitation is exercised are different in the two classes, not by any means because parthenogenesis could not have been introduced among the lower Metazoa, but because nature did not require it, but resorted to the far more practicable and flexible methods of fission and budding."*

* Weismann, ii. p. 221.

Darwin and his followers would assert that none of these animals were created for budding, but that the habit had been slowly acquired and perpetuated, from the advantages it gave its possessors over other forms which only increased by eggs in the ordinary manner, and thus perhaps leading to the supplanting of the latter by the former. The varieties which budded most freely, moreover, would have the best chance to survive.

On the other hand, budding gives no vantage-ground for sexual selection. Even in those cases in which the buds are of separate sexes, as in *Myrianida*, sexual selection would appear to be of comparatively little moment in regard to the issue of the respective elements in the free condition, except in so far as the strongest swimmers of both sexes might pass to the greatest distances from their parent-stock, and thus give rise to a hardier race. This end, however, might have been attained without the production of separate buds, as in those Syllides in which the posterior region discharges, for instance, its eggs without being separated from the anterior. The same occurs in the Heteronereis condition of the Nereids, and in *Dodecaceria*. It may be supposed, however, that the free buds, unimpeded by the anterior region, and with their specially organized swimming-bristles and processes, would be better fitted for dispersing themselves through the water, and intermingling with those from diverse stocks, just as the wind or an insect does in the case of many flowers and shrubs.

Again, many of the Syllides are sedentary, and the buds may be supposed to be a special means of dispersion, yet *Myrianida*, with its long chain of buds, is at least sometimes pelagic, and the buds of *Cephalodiscus* would not appear to subserve this end, which probably is the function of the larvæ from the large eggs of this species.

Nature appears in some cases to expend her energies in budding, and the ordinary sexual elements are not developed; yet in the animal of the coral-like *Filigrana* the latter exist in the parent-stock in front of the bud. Further, budding is a simple method of increase, since only a single form is necessary for this function, and the bud is not only fed and protected by the adult, but—in the case of those which subsequently lead

a free existence—it is brought on the stage in an advanced condition.

In regard to the origin of budding, it may have been inherent in certain of the lower types, and in such as the Annelids may have sprung from the tendency to fork, not infrequently met with; but our knowledge is yet too scanty to warrant conclusions. All that can be said is that a form which, under certain circumstances, increased by buds as well as by eggs had in all probability a better chance of survival than one which developed from eggs only. Further, that budding is remarkably adapted for the habits of many of the types mentioned, such as Zoophytes, Cestodes, Annelids, and Polyzoa.

NOTES ON THE SEAL AND WHALE FISHERY IN 1904.

BY THOMAS SOUTHWELL, F.Z.S.

THE sealing fleet from Newfoundland, in the season of 1904, consisted of twenty-one steamers, a reduction of one, the changes consisting of the withdrawal of the 'Neptune,' 'Harlaw,' 'Terra Nova,' and 'Windward,' and the addition of the 'Bloodhound,' 'Viking,' and 'Eagle.' The 'Terra Nova' was sent out by the Government with the 'Morning,' as a sister relief ship to the Antarctic exploring vessel 'Discovery,' and the 'Windward' was purchased by Messrs. R. Ferguson & Co., of Dundee, to replace the 'Vega,' wrecked in Davis Strait last season.

The vessels left port as usual on the morning of March 10th, the St. John's fleet experiencing some difficulty at first from the ice, which was close packed on the shore; but the more powerful steamers giving a lead to the others, and the floe having slackened somewhat before a westerly breeze, they soon got clear away.

The first to arrive in port from the eastern fishery was the 'Aurora,' which sailed from Westleyville (Bonavista Bay), and was absent only sixteen days, having not only made the quickest but the most successful voyage of the season, her catch consisting of 34,849, only 189 of which were old Harps. Her captain reports that the ice was met with almost at once, the first "Whitecoat" seen on the 11th, and the breeding patch sighted on the 12th, about seventy miles N.E. of Fogo; he estimated the young Seals in this locality at not less than 100,000, and, at once setting to work, he had 4000 pelts on the ice before dusk. This went on day after day, impeded only by stormy weather, the vessel drifting south till she was only six miles outside the Funks; finally, with some little difficulty and delay, she got clear of the ice, and had a good run home. The weather proved very severe; every day a blizzard was experienced, which sometimes lasted for hours. Several other vessels

were in amongst the Seals at the same time, and by April 2nd five had arrived in port well-fished; the 'Walrus,' a vessel of 276 tons, manned by a crew of 120, having 16,720 pelts. In consequence of the heaviness of the ice and the intensity of the frost the more powerful of the ships fared best; the 'Kite,' a small vessel of 190 tons, with a crew of 89 men, was quite unable to contend with her surroundings, and only secured 733 Seals. The great bulk of the young Seals, being killed very early in the season, were rather immature, but those taken later on were in better condition. Very few old Seals of either species were obtained, and very few young Hoods, the 'Diana' alone being fortunate enough to secure about 7000 of the latter; these were obtained well out to sea south-east of the Harps. As these are usually found outside of the Harps, and well to the north-east of them, Sir Robert Thorburn informs me it is supposed, and probably correctly so, that a section of the Harps and most of the Hoods passed away south, thus escaping. It seems likely that most of the Gulf Seals also, as will be seen, escaped.

The reports from the Gulf sealers are very unfavourable, owing to the immense sheets of unbroken ice which prevented the vessels from reaching the young Seals.

The commander of the 'Viking' states that it was the worst year in his experience, and that his vessel was unable to reach the Bird Rocks; her 4394 Seals were taken coming out of the Gulf. The 'Nimrod' reports to the same effect; it was found impossible to get into the Gulf, and her 5000 young Harps were taken in the neighbourhood of St. Paul's before the end of March, after which time only some two or three hundred Seals were killed. She arrived in port on May 2nd.

An unsuitable iron boat from Nova Scotia was wrecked in the Gulf, and the crew taken off the Magdalen Islands by the 'Aurora,' which was sent out for that purpose.

The average take of the twenty-one vessels was 13,546, eight of them having above that number, and thirteen below it; eight vessels had more than 16,000 each, four others between 10,000 and 13,000, and nine under 10,000. The 'Aurora' again this season headed the list with 34,849, of which only 185 were old Harp Seals, very few of which, as already stated, were killed by any of the vessels, and the bulk of those late in the season. The

'Kite,' for reasons already explained, captured only 733 Seals. The total catch of the steamers was 284,473, valued at £80,758, against 317,760, valued at £89,958, in the previous season. To these must be added the Seals taken from the shore, and those secured by the schooners.

In consequence of the readiness with which the breeding Seals were found, the "Whitecoats" were very immature, and the Editor of the 'St. John's Evening Herald,' comparing the season of 1902—the year of the strike, when the vessels did not get away till the 12th, and the main body of the Seals was not found till the 18th—with that just past, points out that whereas the number of Seals taken in the former year was 10,000 less than in the past season, the weight of fat was almost 1000 tons more (6153 tons against 5186 tons), thus clearly showing the advantage of giving the Seals a few days' longer grace.* The growth of the Whitecoats under favourable circumstances is very rapid, but, in addition to the earlier killing, the past spring has, owing to the absence of snow and the severity of the frost, been very unfavourable to their development; the difference, however, in the money value in the two years has been lessened owing to the increase in the price of produce, which is now 4 dols. per cwt.

Hitherto the carcasses of the Seals have been left on the ice after the stripping off of their pelt and fat, but it was said that a whaling vessel, the 'St. Lawrence,' would this season be sent out to collect the carcasses, with a view to extracting the remaining oil, and the conversion of the flesh and bones into manure. How far this has been successful I am not aware.

As is usual, many "panned" Seals were lost owing to fog, or swept away before they could be got on board; the 'Erick' alone is said to have lost 86 "flags" of from 80 to 100 Seals each; she is reported to have killed and "panned" 30,000 Seals in ten days, from March 15th, but her final return is only 17,300. Similar losses were experienced by other vessels. It is therefore evident that vastly more young Seals were killed than were secured, and this wasteful method cannot fail to be regarded with regret.

* Cf. further remarks on this subject in my Notes for 1901 (Zool. 1902, February, pp. 44-45).

WHALES.

In glancing at the reports of the Whale-fishery in past years one cannot help contrasting them with those of the present time, and being struck with the changes which have taken place in the nature of the produce brought home from the Arctic Seas. Years ago the Black Whale was *par excellence* the object of the whaleman's quest, supplemented only by such White Whales, Seals, and Walruses as could be conveniently secured without neglecting the main object of pursuit; but as these valuable animals grew scarcer, smaller game engaged their attention, and Seals bulked largely in the returns, being sought for on the west ice north of Jan Mayen in the months of March and April before the vessels went north in search of Whales off Spitzbergen. In time this sealing became unprofitable, and about the year 1880 the Bottlenose fishery came to the front, reaching its culminating point in 1883, when 535 of these Whales were killed by the Greenland vessels; the next year (1884) the number was 317, and after that date they fell off rapidly, this branch of the industry, like the Seal fishery, being abandoned to the Scandinavians, whose methods are more economical than ours, and who probably still find it profitable. Then the Right Whale failed in the Greenland Seas, where it had once been so abundant, and in the year 1894, for the first time since 1788, the port of Peterhead was unrepresented in this ancient industry; in 1901 even the Dundee vessels forsook these seas, and confined their operations to Davis Strait, where this is the only British port represented. But still other changes have crept in; stations have been established on the shore in likely quarters, and wintering parties left to collect produce by barter with the natives or otherwise, which is taken on board by the whalers or brought home by carriers; and, lastly, the waters of Hudson Strait and the adjoining channels have been invaded, so that the whaler's cargo is of a very miscellaneous character, reminding one more of a Hudson Bay Company's fur ship than of an old-fashioned whaler's, comprising even minerals such as mica and plumbago.

Five vessels from Dundee have been actually engaged in the Whale fishery in the past season; four in Davis Strait and one in Hudson Strait, in addition to which the 'Queen Bess' (72 tons) brought home produce from Hudson Strait, where she

has acted as a store-vessel at the mining settlement, and the 'Albert' (97 tons) still remains in Pond's Bay, her catch having been brought home by the 'Eclipse'; this consisted of 2 Right Whales, 19 White Whales, 3 Walrus, 686 Seals, 16 Bears, 10 tuns of oil, and 5 cwt. of bone.

The 'Active,' which, as usual, went to Hudson Strait, had a double duty to perform; she carried out stores and provisions for the fishing station at Lake Harbour, and to the mines in Repulse Bay, prosecuting the fishery as opportunity offered. She left Dundee on June 9th, and returned on Oct. 22nd. The captain found, on arrival at his destination, that the wintering party had captured one Whale, 8 ft. 9 in. bone, which was taken in Roes Welcome on Sept. 15th, 1903; and subsequently, on Aug. 14th, 1904, the crew killed a second Whale of 9 ft. 3 in. bone. The weather was most unpropitious, and the 'Active' bore up for home on Sept. 29th. I have mentioned the miscellaneous character of the cargoes brought home by the whalers, and as a further illustration give that of the 'Active,' which, in addition to the two Whales, consisted of 69 White Whales, 38 Walruses, 52 Seals, 32 Bears, 157 Fox and 30 Musk-Ox skins, besides 15 tons of mica, and a young Iceland Falcon.

The Davis Strait vessels experienced a constant succession of gales, fogs, and severe frosts—the ice, too, was very heavy—all of which greatly impeded the fishery. Plenty of Whales were seen, but the conditions were such that it was impossible to capture them; the winter, too, set in so early that the failure of the autumn fishery on the west side of the Strait also added to their vexation and disappointment, for there, too, Whales were seen in plenty, which it was beyond their power to pursue.

The 'Diana' was the most fortunate ship of the season, heading the list with three Whales, the first of which was captured on May 21st at the east-side fishery; it yielded 10 ft. 2 in. bone. Pursuing her way north, after some unpleasant experiences drifting in the pack, at the end of June, Dalrymple Rock was reached, where the crew laid in a stock of eggs and "ducks"; then on to Pond's Inlet, where, on July 7th, the second Whale, a fine fish of 11 ft. 1 in. bone, was killed; and ten days after, in the same locality, a third of 8 ft. 1 in. bone was secured. Other Whales were seen, and on Sept. 16th a fine

one was lost through the harpoon breaking ; but no other capture was made, and the 'Diana' returned with a successful cargo of 3 Whales, 23 White Whales, 30 Seals, and 26 Bears, yielding 36 tuns of oil and 45 cwt. of bone.

The report of the 'Eclipse' indicates the difficulties the vessels had to contend with, and, although no serious accidents occurred, the voyage was attended with much anxiety and hardship. When nearing Melville Bay the cold was intense, and the vessel had a hard struggle to fight her way through the ice, which constantly threatened to hold her fast in its pitiless embrace. Slowly she forced her way through till she reached the Bay proper, when the elements proved too strong, and whilst gallantly battling against fog, snow, and ice she was finally beset, and remained fast for twenty-five days. On reaching the Straits fishing-ground it was found that the old ice had not yet disappeared, and that it was being daily augmented by fresh formations, rendering the navigation both difficult and dangerous. Early in July several large Whales were seen, and one, a very fine fish of 12 ft. bone, captured. A few days later a second but much smaller Whale of only 4 or 5 ft. bone fell to her share, and these, with 53 White Whales, a few Seals, Walruses, and Bears, yielding 29 tuns of oil and 22 cwt. of bone, formed the whole of her cargo.

The 'Balæna' captured one fair-sized Whale of 10 tuns of oil and 15 cwt. of bone, and the 'Windward,' after several disappointments, killed a small fish of 7 ft. bone, yielding 8 tuns of oil and 5 cwt. of bone ; her ill-luck continued, for she subsequently fastened to a much larger Whale, which she lost through the line breaking. The crew killed 16 Bears.

The season therefore cannot be regarded as a successful one, the total return for the five whalers being 9 Whales, 104 tuns of oil, and 108 cwt. of bone, to which must be added the cargoes of the 'Queen Bess' and the 'Albert,' making in all 11 Right and 168 White Whales, 45 Walruses, 1135 Seals, 109 Bears, 211 Fox, and 30 Musk-Ox, with 114 tuns of oil and 113 cwt. of bone.

The present price of oil is £21 per tun, and that of whale-bone uncertain, no sales of importance having at present been effected ; £2500 per ton for size bone is being asked. The probable value of the season's produce would be about £16,250.

The American whalers have, I am informed, captured forty-nine Whales in the past season.

The whaling-grounds in the Greenland Seas have been deserted by our seamen, and, as the Norwegian sealers do not penetrate so far north, nothing is at present known as to the state of the ice in the latitudes formerly frequented by the whalers; but the 'Frithjof,' which took out coal for the relief of the "America" North Polar Expedition, twice failed in her attempts to reach Franz Josef Land.

The Finwhale fishery, which has been for some years successfully prosecuted by the Norwegians off the Finmarken coast, has recently been much extended. The first to follow their example was the Newfoundland Cabot Whale-fishing Company, to which I have more than once referred; stations were then established in Iceland, the Faroe Islands, and, in 1903, on the mainland of Shetland, where they were from the first successful.* In the season of 1903 only two stations were worked there, and 126 Whales killed; in 1904 two other stations were opened, and 412 Whales killed. An unlooked-for event was the capture of six or seven Sperm Whales in 1903, and of a large bull Sperm on June 24th, 1904.

The 'Shetland News' of March 12th, 1904, quoting from the 'Newfoundland Trade Review,' describes the success of this fishery from our oldest colony as phenomenal, and states that "whaling's stock is now considered the best investment in the country. Every fifty-mile coastal area (as provided by the law) is now taken up in Newfoundland, and there are also many areas taken up in Labrador. There are now ten whaling stations in operation, and there will be from three to five more next year [1904]. Near most of these there is stationed a Reis-Mullet reducing plant, in which, by proper scientific treatment, every particle of the fish that does not go into oil is reduced to some paying product."

The Finwhales of various species have hitherto been met with in surprising abundance, but how long the serious strain on their numbers, although spread over so extended a range, can be sustained it is impossible to say. The demand for this kind

* Cf. Whale-fishing from Scotland, 'Annals of Scottish Nat. Hist.' April, 1904, pp. 77-90.

of produce is limited, and the prices have of late been ruling so low that the industry seems to one who is only an onlooker in danger of being greatly overdone.

One excellent result, from a biological point of view, has arisen from this fishery. The facilities thus offered for the study of these animals under the most favourable conditions have enabled Prof. Collett and Mr. A. H. Cocks, in Norway, vastly to increase our knowledge of the Finwhales of this side the Atlantic; and Dr. F. W. True, of the United States National Museum, has done the same for those of the Western North Atlantic, proving, in a most exhaustive monograph of the group, that the Finwhales of the American waters are specifically identical with those of the European coasts, and that they occur in both regions in about the same proportions, with the exception of *Balenoptera borealis*, which seems scarce on the American side. The materials for Dr. True's study were derived chiefly from the Newfoundland whaling stations. It does not follow, I think, as I endeavoured to point out in a paper on the migrations of the Right Whale ('Nat. Sci.' June, 1898), that individual Whales roam throughout the vast region ascribed to each species; it may even be that the range of each race is comparatively limited, and that should it become extinct within that limit its place will know it no more, which one fears will be the case with the Right Whale of the Greenland Seas; that a wounded Finner might, in its flurry, rush across the Atlantic is certainly possible—indeed, there is one instance recorded in which such seems to have been the case—but most likely it would find itself amongst strangers in a "strange land." These remarks would equally apply to the Right Whale of the temperate seas of the northern hemisphere (*B. glacialis*).

The only species known to have a restricted and clearly defined range is found in the Pacific—the Californian Grey Whale (*Rhachianectes glaucus*), a very aberrant species.

Dr. True points out that the Finwhales of Newfoundland are smaller in all their proportions than those killed by the Norwegians. As an explanation of this fact, he offers the suggestion, but only as an alternative which he evidently does not adopt, that if the Whales on both sides the Atlantic mingle together—of which commingling there is practically no conclusive evidence

—the Norwegians, who had ten years' start of the Americans, might have killed off all the largest examples ; but this involves the supposition that the individual Whales frequented both sides of the Atlantic habitually and indiscriminately. In addition, there is no evidence that the Norwegian whalers selected the large Whales to the exclusion of the smaller, but they doubtless captured all the fish which "came into their net." The reasonable conclusion therefore seems to be, as above suggested, that the east and west sides of the Atlantic are each frequented by distinct races of the same species.

I must again tender my thanks to Mr. Robert Kinnes, of Dundee, and Sir Robert Thorburn, of St. John's, Newfoundland, for their valuable assistance ; also to the Editor of the 'St. John's Evening Herald,' for copies of his papers containing sealing news.

NOTES AND QUERIES.

MAMMALIA.

The Little Shrew in Aberdeenshire.—A specimen of *Sorex minutus* was found by Miss D. Hamilton at Skene House in October, 1904. She very kindly sent it to me for examination. This is the first record for our county. The creature would seem to be rare with us, for, although I have been giving special attention to the Shrews for some years back, it has not been my fortune to see a local example until now.—GEORGE SIM (Aberdeen).

Whale versus Swordfish and Thresher. — In your notice of Mr. Bullen's book, which appeared in 'The Zoologist' (1904, p. 438), the statement of the author that he is absolutely certain that he has seen the "Thresher" Shark "attacking the Whale at close quarters" reminds me of a most exciting struggle I saw (I think in 1874) while at anchor at St. Vincent, Cape de Verdes, on board the cable-ship laying the St. Vincent and Pernambuco cable. The Whale, in his frantic endeavours to escape from his two enemies, which assailed him simultaneously from above and below, repeatedly jumped clear of the water, amid a perfect cloud of spray and foam. While in the air we could plainly see the Swordfish hanging on to him, and while in the water the immense flail of the Thresher could be distinctly seen and heard. Such a sight as this only comes about once in a lifetime, and once seen can never be forgotten.—REG. B. LODGE (Enfield).

The Mammals of Great Britain and Ireland.—I am glad to see, in the last number of 'The Zoologist,' an appreciative notice of Mr. Millais's new work with the above title, concerning which there can be only one cause for regret, namely, that the high price of the work (eighteen guineas when complete) will place it beyond the reach of many to whom it would be extremely useful. My object, however, in writing is to correct a misapprehension in your notice (p. 464) which concerns myself. Your reviewer observes:—"We read that Mr. Harting also handed him [the author] over his notes which had been collected with the idea of a similar enterprise." I take exception to the words "handed over," which are not the words of the author. My collected observations and notes, which date from 1874 (when the last edition of

Bell's 'British Quadrupeds' appeared), and which now fill a dozen large pamphlet boxes, have not been "handed over" to anyone, but remain in my possession. In enabling my old friend Mr. Millais to refer to them whenever he pleased, I have been only too glad in this way to assist in the production of a work which should reflect more faithfully than any which has yet appeared the present state of our knowledge concerning the mammalian fauna of the British Islands. It would have been a churlish thing on my part to have neither utilized the collections myself, nor allowed others to do so, if so minded. But, while co-operating to this slight extent *pro bono publico*, I feel persuaded that a less expensive work on British Mammals in not more than two octavo volumes, and issued at a cost within reach of working naturalists, the majority of whom are not rich men, would be generally acceptable. For this reason I cherish the idea of producing such a work at no very distant date.—J. E. HARTING.

[The reviewer based his remarks on the following explicit statements in the preface to Mr. Millais's book:—"One man who is thoroughly conversant with the literature of the subject I had always expected to write a good book on British Mammals, but he has given his attention to other subjects, and when I last spoke to him he said he was as far off the project as ever. I allude to my old friend Mr. J. E. Harting." In a footnote it is stated:—"As this work goes to press, Mr. Harting has generously placed the whole of his valuable notes on British Mammals at my disposal." Any inaccuracy that may exist can therefore hardly be laid to the charge of the reviewer.—ED.]

AVES.

The Autumn Songs of the Willow-Wren (*Phylloscopus trochilus*) and the Chiffchaff (*P. rufus*).—In the writer's opinion these birds do not *resume* their songs in autumn, as a recent contributor to 'The Zoologist' seems to think. A few individuals of the above species sing all through the time they remain in Britain, but I have always noticed that as the time for their departure in autumn approaches their songs become more and more feeble. They do not in autumn, after a period of silence, burst into joyous song as so many birds do in late winter or early spring. The only British birds I know that seem actually to renew their full song in autumn after being silent in summer are the Robin (*Erithacus rubecula*) and the Starling (*Sturnus vulgaris*), and they both recommence singing early in August. All other species, whose songs cease in summer, except on rare occasions, do not renew them until the early months of the year. Of course, this is only my own

local experience, and may possibly be somewhat exceptional. — W. GYNGELL (Scarborough).

Pied Wagtail nesting in a Hedge. — On May 7th of last year (1904), whilst searching a low laurel-hedge at Richmond, Surrey, a Pied Wagtail (*Motacilla lugubris*) flew out a few yards in front of me, and I found its nest, containing five eggs, built in the fork of a laurel barely four feet from the ground. The site was just such an one as a Hedge-Sparrow or Linnet might have selected for its nest. The nest itself was built of roots, and lined with hair, but was not so substantially constructed as is usual with the Wagtail. It contained five eggs. I do not believe it was an adopted nest of Linnet or Greenfinch, but that it was a genuine nest of the Wagtail, although possibly hurriedly built through the bird having been disturbed from another nest when just ready to lay. The young, I believe, hatched off safely, and on June 19th I had another look to see if its second brood was being reared in the same nest, but found it was in too filthy and dilapidated a condition for further use, so looked around for it elsewhere. Noticing a grass-root on a holly-hedge about ten yards away, I followed it up, and found, as I expected, that it led to an old Blackbird's nest, in which was the newly-built Wagtail's nest containing five eggs. As it was in a private garden, I have no doubt that this brood also got safely away. Since the foregoing note was penned I notice that the Rev. F. C. Jourdain, in 'The Zoologist' (1904, p. 421), mentions several instances of the Pied Wagtail building in other birds' nests. I might therefore add that, besides the instance above mentioned, and the nest he refers to as having been found by me in 1902, I found a Pied Wagtail's nest, in 1894, built in a Thrush's nest, and containing six eggs, in the lower fork of an elm at Gunnersbury, about a mile from here. — ROBERT H. READ (Bedford Park, W.).

Birds building in other Birds' Nests. — The preceding note reminds me that, besides the Pied Wagtail, many birds build or lay their eggs in other birds' nests, some habitually, others only casually. The following are some instances which I have met with myself:—

Robin's nest built in Thrush's nest on ivied wall, containing four Robin's eggs and one of a Cuckoo. Hedge-Sparrow's nest built in Blackbird's nest in hedgerow. Spotted Flycatcher's nest, containing three eggs, built in Blackbird's nest in hawthorn-bush in hedgerow. Spotted Flycatcher's built in Mistle-Thrush's nest in apple-tree. Pied Flycatcher's, containing five eggs, built over a Marsh Tit's, with three eggs in hole in tree-stump. Greenfinch's, with one egg, in Blackbird's in thorn-bush. House-Sparrow in House-Martin's nest. House-

Sparrow's egg laid in Swift's nest ; the old Swift was sitting on this egg and one of its own. Starling's nest built in Green Woodpecker's hole. Jackdaw's eggs laid in Starling's nest in hole in elm-tree ; also in old Crow's nest. Cuckoo's eggs in various nests. Barn-Owl's eggs in nests of Stock-Dove, and in tame Pigeon's nest in a dovecote. Long-eared Owl's eggs in nests of Sparrow-Hawk and Wood-Pigeon ; young of ditto in Rook's nest, amongst several other Rooks' nests containing eggs. Sparrow-Hawk's nest built on Wood-Pigeon's nest. Honey-Buzzard's built on Squirrel's nest. Merlin's five eggs laid in a Raven's nest on a ledge of rock on a Scotch hillside. Kestrel's eggs in nests of Carrion-Crow, Magpie, Common Buzzard, &c. Pheasant's eggs laid in Partridge's nest ; also in Wild Duck's nest. Oystercatcher's egg in nest of Lesser Black-backed Gull. Green Sandpiper in nests of Squirrel and Song-Thrush.

Doubtless many readers of 'The Zoologist' could add considerably to this list. In addition to these many birds either repair their old nests, or build new ones on their own old nests of preceding years, such as the Rook, House-Martin, Eagles, Buzzards, Osprey, &c. On one occasion I found three nests of Robin, one over the other, the top one containing fresh eggs, and the middle one stale eggs of the preceding year. It may not be generally known that some of the *Limicola* have the same habit. Underneath the nests of Peewit and Avocet, I have found old egg-shells and nesting material of previous nests, which in all probability were made the year before by the owners of the new nests. In one instance, in the hollow amongst the pebbles which did duty for a nest of Oystercatcher, were three fresh eggs laid amongst the bleached bones of another Oystercatcher, which must have been lying there at least a twelvemonth. Sometimes two birds of the same species will lay in the same nest. This is a not uncommon habit among game-birds, but I have found Song-Thrush with eight eggs, Starling with eight, Wood-Pigeon three, Tufted Duck twenty, Black-headed Gull five and six—in each case evidently the produce of two females.—ROBERT H. READ (Bedford Park, W.).

Hooded Crow at St. Albans.—I beg to record the shooting of a fine male Hooded Crow (*Corvus cornix*), early last October, by J. Last, the gamekeeper, on Oaklands, a small estate near here. The bird was observed feeding ravenously upon a Rabbit caught in a trap. It was shot at whilst so engaged, but flew into an adjacent tree. The keeper thereupon stalked the bird, and fired again, this time with success. It is rare indeed that one is enabled to get a second shot at these birds, and this particular bird must have been suffering from the pangs of

hunger to take up its station hard by the trap in the apparent expectation that the genus *Homo* would retreat, and permit itself to be shot at the second attempt. The bird—which is a very rare visitor here—has been beautifully set up by Mr. Spary, the local taxidermist. — W. PERCIVAL WESTELL (5, Glenferrie Road, St. Albans, Herts).

Late Breeding of Barn-Owl (*Strix flammea*).—I have this week (Dec. 4th, 1904) received for preservation an adult Barn-Owl and two young. The latter, though well able to fly, had a quantity of down still adhering to tips of the feathers.—CHARLES JEFFERYS (Tetbury, Gloucestershire).

Wood-Pigeons and Stock-Doves.—During the last eight years the former species have decreased in a wonderful way in this part of Notts, and I do not hesitate to say we have not one now where we had ten in the early nineties; but Stock-Doves have increased. Ten years ago I only remember two or three pairs nesting, and little flocks of sixes and sevens; now they nest wherever they can find a suitable place, and to-day (Jan. 3rd) I have seen in a field here a flock of between two and three hundred—I should be inclined to say nearer three than two. I have never seen such a flock before. The Grey Crow is decreasing in this part of the county; I have not seen more than twenty this winter, and I have seen one hundred in a day years back.—J. WHITAKER (Rainworth Lodge, Notts).

Waterhens nesting late in the Season.—On the ornamental waters of Weston Park, Sheffield, a brood of Waterhens (*Gallinula chloropus*) were hatched out during the last week of August, 1904. The nest was built on a clump of holly-branches, secured in the middle of a pond. It was most interesting to watch how, in the absence of the parents, one of the fully-fledged immature birds of an earlier brood would enter the nest and view, with tender curiosity, its baby brothers and sisters. Sometimes this bird would quit the nest before the return of one or both parents, but even when it remained on, its presence was never objected to. In fact, at one time I noted quite a large united family gathering, consisting of both parents, a fully-grown immature plumed bird, and a brood of nestlings, in the nest, with two other immature birds swimming round it. The nestlings were fed assiduously for some weeks by several members of the former brood, as well as by their parents.—C. J. PATTEN (University College, Sheffield).

Oystercatcher (*Hæmatopus ostralegus*) inland in Cheshire.—On a spit of sand at Budworth Mere, near Northwich, I saw an Oystercatcher, consorting with a flock of Black-headed Gulls, on Dec. 4th,

1904. This bird abounds on the sand-banks in the Dee and Mersey estuaries, but, so far as I know, it has not hitherto been noticed inland in Cheshire.—CHAS. OLDHAM (Knutsford).

Black-headed Gull (*Larus ridibundus*) assuming the Hood in Winter.—On Dec. 31st last I saw, on the Dee below this city, a Black-headed Gull with the brown hood almost entire. In the north this is, in my experience, an exceptionally early date for the assumption of the dark mask of the breeding plumage. The earliest date I have previously noted was Jan. 17th, 1903, and occasionally in February in former years. Instances in the south are apparently of more frequent occurrence; Messrs. D'Urban and Mathew, in their excellent work, the 'Birds of Devon,' quote several early dates for that county. Throughout the autumn and winter months this species is very abundant in this neighbourhood, but I consider the Common Gull (*Larus canus*) to be even more numerous. These last, with few exceptions, are always in adult plumage.—S. G. CUMMINGS (Chester).

Buffon's Skua (*Stercorarius parasiticus*) in Somerset.—The specimen of Buffon's Skua shot at Axbridge in October, 1903, to which Mr. Stanley Lewis refers in 'The Zoologist' (1904, p. 461), makes, as far as I know, the fourth example recorded as taken in Somerset. The first, an adult specimen, was shot at Nynhead, near Wellington, at the end of October, 1862 (*cf.* Zool. 1863, p. 8448). The second, in immature plumage, was shot near Stolford, Sept. 18th, 1873 (*cf.* Zool. 1874, p. 3869). Both these examples were examined by the late Cecil Smith. In October, 1891, numbers of these birds were driven by severe gales into the English and Bristol Channels, and one was shot at Clevedon (*cf.* D'Urban and Mathew, 'The Birds of Devon,' ed. ii. p. 397). I have also received other confirmation of the capture of this specimen.—F. L. BLATHWAYT (Lincoln).

Red-throated Diver (*Colymbus septentrionalis*) in Cheshire.—On Nov. 12th, 1904, I watched a Diver for some time on Tatton Mere, near Knutsford. It looked but little larger than the Great Crested Grebes, of which there were a number on the water, but even at a distance it might be readily recognized by the shorter and thicker neck and stouter, slightly recurved bill; its long, cigar-shaped body, too, lacked the curve above the water-line which a Grebe's has. In the dim afternoon light it was impossible with the binoculars to make out the white spots on the back which distinguish the Red-throated from the Black-throated Diver in winter plumage, but when I went again to the mere with Messrs. Coward and Cummings on the 19th, we could,

with a telescope, see the white edgings of the feathers quite plainly. This Diver has not been noticed previously on any of the Cheshire meres.—CHAS. OLDHAM (Knutsford).

Late Nesting of the Great Crested Grebe (*Podiceps cristatus*).—By the end of August most of the young Great Crested Grebes are independent of their parents, and it is unusual, on the Cheshire meres, to see the old birds feeding young ones in September. In 1904, however, two pairs of Grebes on Tatton Mere, near Knutsford, had unusually late broods—possibly their young had been destroyed, and they had laid again in late summer. Be that as it may, on Sept. 18th I saw a pair of Grebes in attendance on two downy young ones, and a third adult was feeding a single young one rather larger than the other two. I saw these three young ones being fed at intervals up to Oct. 15th, and on Nov. 6th the two smaller birds were still following their parents with querulous hunger cries. On the afternoon of Nov. 12th one of these young ones was still calling incessantly, and I saw it fed several times by one of the old birds.—CHAS. OLDHAM (Knutsford).

Some Old Welsh Bird Notes.—I have often wished that some of the writers who in the earlier part of the nineteenth century published tours in Wales had mentioned the birds they saw. But hardly any of them have done so. And when the other day I picked up a copy of the 'Journal of a Tour in North Wales,' by Arthur Aikin, published in 1797, which, according to the title-page, included observations in mineralogy and other branches of natural history, my hopes revived. But on turning over the pages I found that, although there was a good deal about geology, and something about plants, birds were only mentioned some half-dozen times. As, however, the tour was made as long ago as 1796, and the author had evidently had some training as a naturalist, these few bird-notes may be trusted, and will perhaps be interesting to the readers of 'The Zoologist.'

Speaking of the Berwyns, which he crossed from Llangynnog to Bala, the author writes:—"Kites, moor-buzzards, and other birds of prey here make their nests in security; and the long heath shelters the grouse, a race that would have been extinct here but for the wide range of these wild mountains, and which, notwithstanding their protection, is rapidly on the decline, owing principally to the improved state of the roads, which admit the carriage of game to greater distances than formerly." The range of high slate-rocks, worn into caverns and recesses by the dashing of the waves, to the north of Aberystwyth Castle, afforded at that time a secure abode for Hawks, Ravens, and various species of Gulls, and other sea-birds. On July

31st the author and his companions went from Aberystwyth to the Devil's Bridge. On the way they saw "a moor-buzzard [Marsh-Harrier] perched on a bush in the middle of a boggy field; it is a very voracious and destructive bird, and distinguished from the rest of the genus by its long slender legs." Midway down the glen of the Rhydiol "we saw several

' Kites that swim sublime,
In still repeated circles screaming loud,'

skirting, with an easy flight, the sides of the thickets in search of prey, or floating with almost motionless wings along the windings of the vale." Later, on a crag immediately above the union of the torrents of the Rhydiol and Funach [Mynach], they saw several Kites perched. The Kite was such a well-known bird in those days that there is no reason to suppose that the author, to some extent a trained naturalist, mistook Buzzards for Kites, although he never mentions the former. Indeed, the Kite was probably the commoner bird in this locality. On Snowdon Aikin saw three Ring-Ouzels amid the clouds on the summit, and the fact that he knew and recognized this bird makes one regret the more the paucity of his bird-notes. He writes that the Eagle was an occasional visitant to the loftiest crags, speaking apparently from hearsay, although he seems to have been there in the previous year also. On the Orme's Head multitudes of Gulls, Corvorants (*sic*), Ravens, and Rock-Pigeons are said to have taken up their abode, as well as the Peregrine Falcon. The abundance of the Kite and the mention of the Marsh-Harrier are the only points of especial interest in these few notes.—O. V. APLIN (Bloxham).

THE ZOOLOGICAL SOCIETY'S GARDENS.

DURING the winter months the additions to the Zoological Society's Menagerie usually fall below the average of those of the summer, both in number and importance. In December of last year they were not very numerous, but one or two are worthy of a passing notice. First and foremost may be placed a young male of the Greater Kudu, from Somaliland, presented by Major Irvine. There are now in the Gardens three examples of this species, which has many claims to rank as the most beautiful and graceful of all Mammalia.

The unrivalled collection of Bears, containing two or more examples of the Sloth, Polar, Malayan, Himalayan, Japanese, American Black, Grizzly, Brown, and Syrian, has been enriched by the presentation of a very fine three-year-old specimen of the Manchurian or Kamschatkan Bear, described from its alleged propensity for Salmon poaching as *Ursus piscator*. Judging from its form and general appearance, however, this specimen appears to represent merely a local race or subspecies of the Brown Bear (*U. arctos*), though distinguishable from examples of the European form of that animal by the profuseness of the hair-growth on the ears.

Examples of Insectivora, if we except the Common Hedgehog, are always rare in menageries. The Society may therefore be congratulated upon having received upon deposit three specimens of the Tenrec (*Centetes ecaudatus*), the giant of the order, and an inhabitant of Madagascar. Unfortunately the exclusively nocturnal habits of this animal render it an unsatisfactory object for exhibition from the visitors' point of view.

In the Monkey House may be seen two recently received examples of the West African Baboons, *Papio sphinx* and *P. anubis*; also a young specimen, from Northern Nigeria, of Pousargue's Guenon (*Cercopithecus pousargueti*), a species not previously exhibited in the Gardens, and two fine deposited representatives of the Lion Marmoset (*Midas rosalia*). Marmosets do not, as a rule, thrive in captivity, and have seldom lived long in the Gardens. The attempt, however, is now being made to keep them under glass as a protection against draught and a prevention against indiscriminate feeding by visitors. What measure of success, if any, will attend this experiment remains yet to be seen.

So far as Birds are concerned, the following call for special comment:— Two specimens of the Victoria Crowned Pigeon (*Goura victoria*), a handsomer bird than the commoner species, *G. coronata*, of which there was a pair in the Gardens last year; a Blue-necked Cassowary (*C. intensus*), from New Guinea, which adds one more to the exceptionally fine series of Cassowaries now on exhibit; and a Dabchick, or Little Grebe. The accession of the latter will give visitors to the Diving Birds' House at feeding-time an opportunity for comparing the different methods of subaquatic progression independently acquired by the Cormorants, the Grebes, and the Penguins. Some Divers, Guillemots, Razorbills, or Puffins would make a most welcome and interesting addition to the series, should a chance of procuring specimens of these species for the Society be afforded to any readers of 'The Zoologist.'

R. I. P.

